

# Congestive heart failure clinics and telemedicine: The key to reducing hospital readmissions in the United States

Devyani Ramgobin<sup>1</sup>, Maique Vo<sup>1</sup>, Reshma Golarmari<sup>2</sup>, Rahul Jain<sup>3</sup>, Rohit Jain<sup>2</sup>

<sup>1</sup>Touro College of Osteopathic Medicine, Middletown, New York, United States

<sup>2</sup>Department of Internal Medicine, Penn State Milton S. Hershey Medical Center,  
Hershey, PA, United States

<sup>3</sup>Indiana University School of Medicine, Bloomington, Indiana, United States

## Abstract

*The United States healthcare system currently faces an economic challenge related to frequent hospital readmission rates. As such, hospitals have begun implementing strategies to reduce readmission rates for specific medical conditions such as congestive heart failure, which had a 30-day readmission rate of 23.2% in 2014. Patient education and frequent monitoring of symptoms have since allowed patients to work together with doctors and nurses to take charge of their healthcare management. Due to heart failure clinics and the rise of telemedicine and telemonitoring, heart failure readmission rates have since decreased. (Cardiol J)*

**Key words:** congestive heart failure, telemedicine, telemonitoring, heart failure clinics

## Introduction

Readmission is a major concern for the United States (US) healthcare system. Under the Affordable Care Act's Hospital Readmission Reduction Program (HRRP), hospital systems are penalized monetarily if they have a higher than expected 30-day readmission for 6 conditions [1]. The Center for Medicare and Medicaid Services (CMS) can withhold anywhere from 1% to 3% of Medicare reimbursements for the readmissions of congestive heart failure (CHF), coronary artery bypass graft surgery, acute myocardial infarction, elective primary total hip/knee arthroplasty, pneumonia, and chronic obstructive pulmonary disease. Under the HRRP, CMS evaluated a total of 3129 hospitals for the fiscal year 2020, and 2583 (83%) of these hospitals will face penalties, which is estimated at \$563 million dollars over the course of 1 year [2].

In a 2014 comparison of 7-day and 30-day readmissions by Fingal et al. [3], nearly 10% of Medicaid patients with a diagnosis of either CHF or schizophrenia were readmitted within 7 days of discharge. The top 5 diagnoses with the highest 30-day readmission rates ( $n = 27,698,101$ ) were as follows: CHF (23.2%), schizophrenia (22.9%), respiratory failure (21.6%), alcohol-related disorders (21.5%), iron deficiency and other anemias (21.2%) (Fig. 1) [3]. In the US, CHF affects 2–3% of the population, with a slightly higher prevalence in males (10%) compared to females (8%) [1]. Given that the CMS can withhold at least 1% of Medicare reimbursement for a diagnosis such as heart failure (HF), and the 30-day readmission rate for HF is 23.2%, the American healthcare system is becoming increasingly burdened with juggling between optimizing patient care and preventing readmissions.

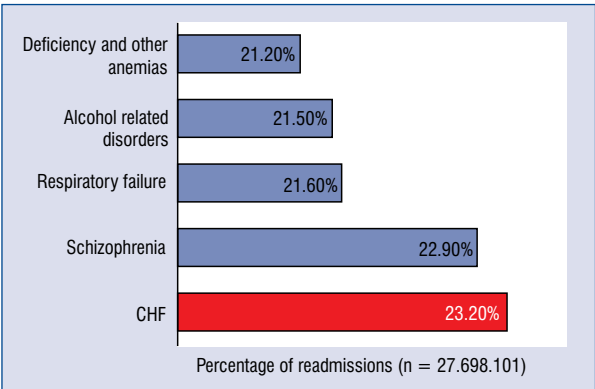
**Address for correspondence:** Dr. Devyani Ramgobin, Touro College of Osteopathic Medicine, Middletown, NY 10940, United States, tel: 917-400-5170, e-mail: dramgobi@student.touro.edu

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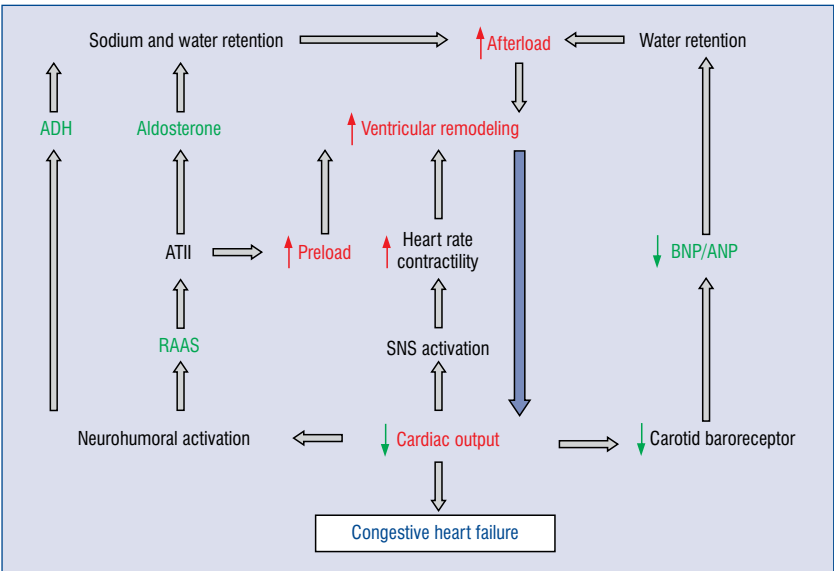


**Figure 1.** Top diagnoses with the highest 30-day readmission rates out of 27,698,101 readmissions. Red bar: congestive heart failure (CHF) accounts for 23.2% of all readmissions within 30 days.

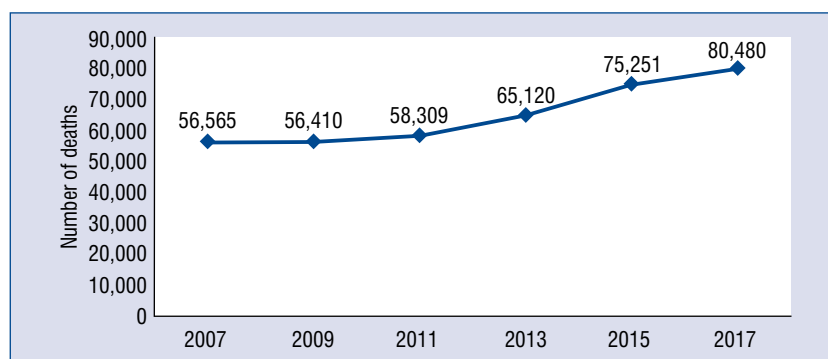
Pathophysiology of congestive heart failure

Congestive heart failure is an accumulation of myocardial injury that ultimately leads to counterproductive remodeling of the heart [4]. CHF results in reduced cardiac output, leading to compensatory effects by the body through neurohumoral activation and activation of the sympathetic nervous system (Fig. 2). There are two types of HF that commonly present in patients: systolic and diastolic. Systolic heart

failure is referred to as HF with reduced ejection fraction (HFrEF), which presents with lower-than-normal left ventricular ejection fraction on echocardiogram [5]. The myocardium is unable to contract adequately and, as a result, ejects less oxygen-rich blood into the body. Fatigue and shortness of breath are common symptoms. In diastolic HF, also known as HF with preserved ejection fraction (HFpEF), patients present with left ventricular diastolic dysfunction [6]. In HFpEF, the myocardium contracts normally but a thickened left ventricle reduces compliance, resulting in decreased filling capacity and thus cardiac output. Decreased cardiac output results in deactivation of the carotid baroreceptors and activation of the renin–angiotensin system [7]. Angiotensin II increases afterload by activating vasoconstriction to the blood vessels, aldosterone increases preload by increasing sodium and water retention, and antidiuretic hormone stimulates water retention [8]. Without B-type natriuretic peptide and atrial natriuretic peptide, the water retention exacerbates the symptoms of CHF, leading to damage of left ventricular remodeling to compensate for the increased peripheral resistance [7]. The body compensates by stimulating the sympathetic nervous system to increase heart rate and contractility, which increases stress on the heart. Increasing contractility increases the cardiac workload resulting in dilation and hypertrophy of the cardiac heart muscle. In a failing heart, the compromised ventricles are unable to pump the blood



**Figure 2.** Mechanism of congestive heart failure; ADH — antidiuretic hormone; ANP — atrial natriuretic peptide; ATII — angiotensin II; BNP — B-type natriuretic peptide; RAAS — renin–angiotensin–aldosterone system; SNS — sympathetic nervous system.



**Figure 3.** Heart failure mortality rates in the United States from 2007 to 2017. Trendline shows an increase in mortality over a 10-year period.

forward to the rest of the body, resulting in fluid accumulation into the lungs and the rest of the body.

### **Congestive heart failure morbidity and mortality rates**

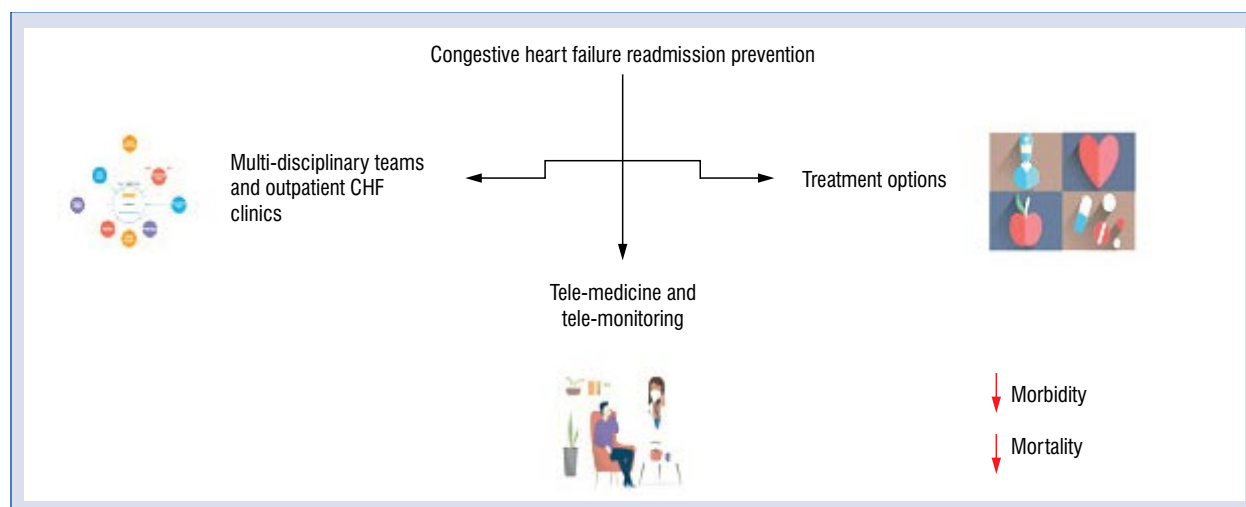
In a 2020 updated report from the American Heart Association, an estimated 6.2 million Americans over the age of 20 years have HF. In 2016, hospital discharges with a diagnosis of CHF numbered 809,000, and in 2017 the mortality rate from CHF was 80,480, a 42% increase from 56,565 in 2007 [9, 10]. As has been shown, there has been a steady increase in mortality from HF (Fig. 3). Heidenreich et al. [11] estimated that the medical cost of CHF admissions will increase from \$20.9 billion in 2012 to \$53.1 billion in 2030, with the majority (80%) being attributed to hospitalization. Similarly, their projections show the prevalence of HF increasing by 46% from 2012 to 2030 [11]. Among Medicare patients, the prevalence of HF was 44% in 2010, with HF admissions being the costliest preventable hospitalization at an average \$10,775 [12].

Several factors play roles in the high readmission rate of CHF. In an analysis done by Inamdar, some of the major causes of readmission were shown to be due to medication noncompliance, smoking, diet noncompliance, failure of documentation of discharge information and patient education, and comorbidities such as hypertension and diabetes mellitus [1]. Under the HRRP, hospitals have since been incentivized to come up with strategies to decrease the number of readmissions. Some of these strategies include multidisciplinary HF clinics, visiting nurse services, physician-directed HF transitional care programs, telemonitoring at home, and 1-week follow-ups. Inamdar also reports that HF clinics reduced all cause readmission rates by

50% [1]. During the HRRP implementation phase the 30-day risk-adjusted readmission rate declined from 20% to 18.4%; however, the 30-day mortality rate increased from 7.6% to 9.3% [13].

### **Congestive heart failure clinics and outcomes**

An important reason why readmission rates have effectively decreased is due to outpatient HF clinics, home intervention methods, and medications. Because HF disproportionately affects the older population, the management goals focus on maintaining and optimizing patient capabilities (Central illustration). Several classes of drugs have been indicated in the treatment of HF, such as diuretics, angiotensin converting enzyme inhibitors, and more (Table 1). For CHF patients to remain stable after discharge, fluid balance, blood pressure, and heart rate must be medically optimized [14]. This can be monitored during clinic follow-up or at home via implantable devices that transmit data to healthcare providers. CHF clinics, commonly known as HF clinics, have been developed to help patients diagnosed with CHF manage their condition. By educating patients on their disease and encouraging active participation in their treatment, one goal is to reduce the need for readmission to hospitals for CHF exacerbations. It is important that patients being discharged also have a strong support system and home environment so that they can maintain functional independence. Caregivers may also accompany patients to clinic appointments, thus ensuring proper follow-up after discharge. Outpatient clinics can help in educating patients and caregivers on weight management, medication compliance, dietary changes, and exercise regimens. By seeing a multidisciplinary team



**Central illustration.** Key proponents in reducing readmission rates related to congestive heart failure (CHF).

**Table 1.** Drugs commonly used in the treatment of heart failure (HF), their mechanisms of action, and effects.

HF treatments	Drug names	Mechanism of action	Effects
Angiotensin converting enzyme (ACE) inhibitors	Captopril, enalapril, fosinopril, lisinopril, ramipril	Competitively inhibit the conversion of angiotensin I to angiotensin II, inhibit bradykinin metabolism, promote sodium and water excretion by inhibiting angiotensin II-induced aldosterone secretion	Reduces preload and afterload on the heart, exerts reno-protective effects via dilation of renal arterioles, reduces cardiac and vascular remodeling
Angiotensin receptor blockers (ARBs)	Candesartan, losartan, valsartan	Prevents angiotensin II from binding to its receptor	Prevents vasoconstriction and aldosterone secretion
Calcium channel blockers	Ivabradine	Blocks hyperpolarization-activated cyclic nucleotide (HCN) gated channel responsible for cardiac pacemaker funny current	Decreases heart rate, cardiac output and oxygen demand
Beta-blockers	Bisoprolol, metoprolol, carvedilol	Blocks response to beta-adrenergic stimulation by preventing ligand binding of the beta-adrenergic receptor by norepinephrine and epinephrine; cardio selective for beta-1 at low doses	Decreases heart rate, contractility, conduction velocity, and relaxation rate of myocardial tissues
Aldosterone antagonists	Spironolactone, eplerenone	Competitively binds receptors at aldosterone-dependent sodium-potassium (Na-K) exchange site in distal renal tubules	Increases excretion of sodium, chloride and water; increases retention of potassium and hydrogen ion
Diuretics	Furosemide, bumetanide, torsemide, chlorothiazide, hydrochlorothiazide, triamterene, metolazone, indapamide	Loop diuretics: Inhibit cotransport of Na-K-2Cl at the thick ascending loop of Henle Thiazide diuretics: Inhibit sodium-chloride transporter at the distal renal tubule Potassium sparing diuretics: Inhibit sodium channels at the cortical collecting tubules	Promotes diuresis, depletion of sodium and total body volume resulting in decreased cardiac output
Angiotensin receptor neprilysin blockers	Sacubitril/valsartan	Sacubitril: neprilysin inhibitor. Neprilysin degrades atrial and B-type natriuretic peptides as well as bradykinin Valsartan: angiotensin II receptor type I inhibitor	Promotes relaxation of blood vessels, sodium excretion and fluid retention

**Table 2.** Summary of studies done to evaluate the readmission rates between patients who had physician follow-up compared to those without follow-up.

Author	Country	Study	Outcome
Tung et al., 2017	Taiwan	13,775 patients discharged from hospitals in 2010 followed for association between 7-day follow-up and 30-day readmission	Early physician follow-up of HF patients was associated with lower readmission rates compared to no physician follow-up (HR 0.54; 95% CI 0.48–0.60)
Hernandez et al., 2010	United States	Observational analysis of patients 65 years or older with HF	Patients discharged from the hospital, who have higher early follow-up rates, also have lower 30-day readmission rates
Jain et al., 2010	United States	138 HF patients during the period June 2005 through June 2006 were evaluated for outcomes through September 2007	4 HF clinic patients (n = 27) were readmitted 5 times 85 non-HF clinic patients (n = 111) were readmitted 187 times (p < 0.001)  A subgroup analysis of crossovers from the non-HF clinic to HF clinic group (n = 39) revealed a 60% reduction in readmission
Tse et al., 2018	United States	Systematic review and meta-analysis of randomized controlled trials and real-world studies	Telemonitoring reduced hospitalization rates of HF patients (n = 31,501) by 24% over a 6-month period, and by 27% over a 12-month period
Cleland et al., 2005	United States	Comparison between HTM, NTS, and usual care on improving outcomes for patients with HF who are at high risk of hospitalization or death	Similar numbers of admissions and mortality among patients in the HTM and NTS groups. Patients in the HTM group had reduced mean duration of admissions by 6 days (95% CI 1–11). Patients in the usual care group had a higher 1-year mortality (45%) than patients in the NTS (27%) and HTM (29%) groups (p = 0.032)

CI — confidence interval; HF — heart failure; HR — hazard ratio; HTM — home telemonitoring; NTS — nurse telephone support

at an HF clinic, a patient's care is tailored to their specific needs. Multidisciplinary teams include a cardiologist, specialized HF nurses, pharmacists, physiotherapists, social workers, dieticians, and other allied health professionals [15]. It is especially important for patients being discharged to be followed up at either their doctor's office or an outpatient clinic for management of their condition. Outpatient clinic visits with a physician or health-care provider after discharge prove to be important in reducing readmission for HF. In a Taiwanese study of 13,577 HF patients, early follow-up with a physician within 7 days of discharge was associated with a lower readmission rate (Table 2) [16]. Similarly, an extensive observational analysis conducted by Hernandez et al. [17] showed that patients who were discharged and received early follow-up with a physician had lower 30-day readmission rates. In a study comparing patients followed in outpatient management vs. no management, only 4 (n = 27)

managed outpatients were readmitted 5 times, whereas 85 (n = 111) patients who did not have follow-up accounted for a total of 187 readmissions (p < 0.001) [18].

### Advent of telemedicine

Due to advancements in digital technology and Internet access, coupled with ever changing circumstances, telemedicine has recently become increasingly popular. Telemedicine is the use of video and audio technology, such as phones and webcams, to electronically connect a patient to a health care provider remotely [19]. Telemedicine is used to deliver patient care and provide follow-up and education to patients who may not be able to visit a doctor's office as soon as possible. It is not only cost effective but it also provides healthcare professionals the opportunity to see and talk to their patients in real time [20]. The efficacy and



ease of seeing a healthcare professional in the comfort of your own home is an opportunity many do not pass on. Not only can patients visit with a doctor, but they can also talk to behavioral health counselors, dieticians, social workers, and other professionals while at home. In the management of CHF, telemedicine could be utilized to follow up patients leaving the hospital, ensuring they are receiving adequate care. Healthcare providers can also remotely telemonitor and review vitals from patient's in-home devices such as blood pressure monitors and pulse oximetry. Telemonitoring is the continuous assessment of a medical condition by way of home monitoring systems or implantable devices that automatically transmit vital signs and other physiological data to medical professionals. Vital signs can be used to check for decompensated HF by measuring parameters such as heart rate, blood pressure, heart rate variability, urine output, and weight gain [21]. Remote data collection can also be done by patient questionnaires that monitor vital signs and symptoms daily. It is not only non-invasive but also much easier for a patient to continue care in their own home. Home telemonitoring has been found to reduce the average number of days spent in the hospital, and patients who received home telemonitoring or nurse telephone support had a better 1-year mortality outcome than patients who received usual care ( $p = 0.032$ ) [22]. In a meta-analysis by Tse et al. [21], telemonitoring reduced hospitalization rates of HF patients ( $n = 31,501$ ) by 24% over a 6-month period, and by 27% over a 12-month period. Providers can also utilize hemodynamic monitoring by way of implantable cardiac devices, such as CardioMEMS and HeartPOD, which continuously transmit cardiac or vascular pressures to a remote system that can be reviewed. Here, doctors can assess increases in intracardiac and pulmonary arterial pressures, which may indicate oncoming decompensation of HF [21]. Therefore, both telemedicine and telemonitoring can be utilized by healthcare professionals to effectively assess patients being discharged from the hospital. These interventions can reduce 30-day readmission rates by decreasing the likelihood of CHF exacerbations.

## Conclusions

Heart failure costs the US healthcare system billions of dollars annually. Hospitalizations are expensive, and readmission rates have increased the burden on hospitals due to decreased compensation for readmissions. On the other hand, patients who

are discharged and do not follow up with a provider for management often have poorer outcomes than those who do undergo follow-up. Outpatient clinics and telemedicine/telemonitoring are crucial for reducing the readmissions rates of patients with HF and for achieving better health outcomes. Given that some HF patients have significant barriers to accessing medical care outside of the hospital, such as physical inability, lack of transportation, or residing in a rural area, telemedicine provides the ability to receive the care they need. Together, clinics and telemedicine/telemonitoring interventions help to create a system that works with patients to achieve their health goals. We are hopeful that telemedicine and outpatient clinics will continue to reduce patient's readmissions and mortality and play a key role in caring for the aging population.

**Conflict of interest:** None declared

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